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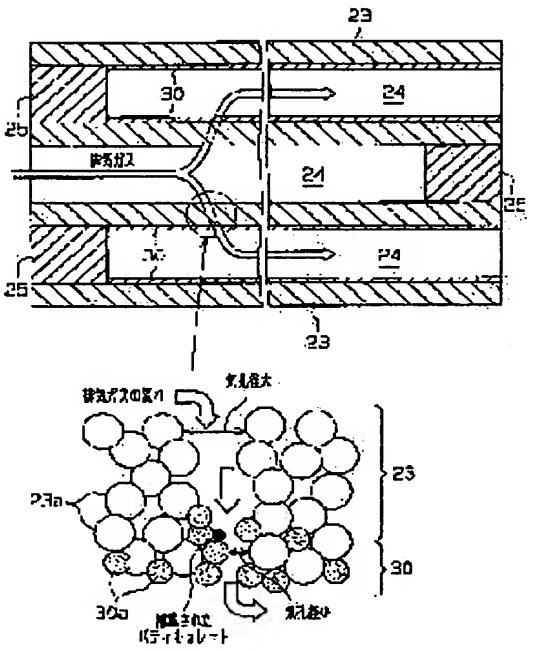
(54) FILTER FOR CLEANING EXHAUST GAS

(57)Abstract:
PROBLEM TO BE SOLVED: To enhance the efficiency of collecting particulate included in an exhaust gas.
SOLUTION: Plural through-holes, partitioned by cell walls 23, are formed in a filter body 19. One opening at the end of two openings formed at both ends of each throughhole 23 is alternately sealed with a sealing material 25. Ceramic coat layer 30, having pore size smaller than the average pore size of the cell wall 23, is coated on the inner surface of the cell wall 23 consisting the throughhole 24 which is open on the downstream end of the filter body 19.



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CLAIMS

[Claim(s)]
[Claim 1] By having two or more through tubes divided with the cell wall, carrying out the closure of one of two openings formed in the both ends of each through tube by turns with a sealing agent, and making said cell wall pass the exhaust gas discharged by the internal combustion engine In the exhaust gas purification filter from which the particulate contained in exhaust gas is removed The exhaust gas purification filter characterized by preparing a ceramic coat layer with either smaller than that of said cell wall in the cell wall side which forms the through tube which carries out opening in the downstream end face of the body of a filter at least among an average pore diameter and average porosity.
[Claim 2] The average thickness of said ceramic coat layer is an exhaust gas purification filter according to claim 1 characterized by being thinner than that of said cell wall.
[Claim 3] The average pore diameter of said ceramic coat layer is an exhaust gas purification filter according to claim 1 or 2 characterized by being set up within the limits of 10 micrometers - 20 micrometers.
[Claim 4] The average porosity of said ceramic coat layer is an exhaust gas purification filter given in either among claims 1-3 characterized by being set as 10% - 30% of within the limits.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to an exhaust gas purification filter.
[0002]
[Description of the Prior Art] The number of an automobile is increasing by leaps and bounds, and the increment of it also with the rapid amount of the exhaust gas taken out by the internal combustion engine of an automobile in proportion to it is being enhanced. Since the various matter contained in the exhaust gas which especially a diesel power plant takes out becomes the cause which causes contamination, in current, it is having effect serious for a world environment. Moreover, the research result that particulates, such as soot contained in exhaust gas, become the cause which sometimes causes reduction of an allergy failure or a sperm count is also reported by recently. That is, it is considered to be a urgent technical problem for human beings to take the cure which removes the particulate in exhaust gas.
[0003] The exhaust gas purification filter of various varieties is proposed under such circumstances. Since it generally has the chemically stable advantage [thermal resistance, a mechanical strength, and collection efficiency are high and], the porosity sintered compact of silicon carbide is used as a formation ingredient of an exhaust gas purification filter in many cases. The exhaust gas purification filter has two or more through tubes divided with the cell wall. The closure of one of two openings formed in the both ends of each through tube is carried out by turns with the sealing agent. Therefore, as the exhaust gas which invaded from the upstream end face of an exhaust gas purification filter escapes from and comes out of a downstream end face, it surely passes a cell wall. The particulate contained in exhaust gas cannot pass a cell wall, but uptake is carried out there. Consequently, only the purified exhaust gas is discharged from the downstream end face of the body of a filter.
[0004]
[Problem(s) to be Solved by the Invention] However, with the conventional exhaust gas purification filter, as long as the particulate of ultralow volume passes a cell wall with exhaust gas, completely, uptake of the particulate is carried out and it can be referred to as impossible. Then, although what is necessary is just to make the average porosity of a cell wall high in order to gather particulate collection efficiency, exhaust gas stops being able to pass a cell wall easily, and pressure loss becomes high. Pressure loss means what lengthened the pressure value of the downstream from the pressure value of the filter upstream. Receiving resistance, in case exhaust gas passes a filter is the greatest factor which brings about pressure loss. Therefore, if pressure loss becomes high, the fuel consumption of a diesel power plant etc. will get worse. If the average porosity of a cell wall is enlarged, while pressure loss will become small in short, particulate collection efficiency falls. On the contrary, if the average porosity of a cell wall is made small, while particulate collection efficiency will become large, the dilemma of becoming large produces pressure loss.
[0005] This invention is made paying attention to the trouble which exists in such a Prior art. The purpose is in raising the particulate collection efficiency included in exhaust gas.
[0006]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, in invention according to claim 1 By having two or more through tubes divided with the cell wall, carrying out the closure of one of two openings formed in the both ends of each through tube by turns with a sealing agent, and making said cell wall pass the exhaust gas discharged by the internal combustion engine In the exhaust gas purification filter from which the particulate contained in exhaust gas is removed Let it be a summary for either to have prepared the ceramic coat layer smaller than that of said cell wall in the cell wall side which forms the through tube which carries out opening in the downstream end face of the body of a filter at

least among an average pore diameter and average porosity.
[0007] In invention according to claim 2, the average thickness of said ceramic coat layer makes it a summary to be thinner than that of a cell wall in an exhaust gas purification filter according to claim 1.
[0008] Let it be a summary to set up the average pore diameter of said ceramic coat layer within the limits of 10-20 micrometers in invention according to claim 3 in an exhaust gas purification filter according to claim 1 or 2.
[0009] Let it be a summary to set the average porosity of said ceramic coat layer as 10 - 30% of within the limits in an exhaust gas purification filter given in either in invention according to claim 4 among claims 1-3.
[0010] Next, an operation of this invention is explained. Since the eye closure of the both ends of the body of a filter is carried out by turns with the sealing agent according to invention according to claim 1, as the exhaust gas which invaded from the upstream end face of the body of a filter escapes from and comes out of a downstream end face, it surely passes a cell wall. At this time, the particulate contained in exhaust gas cannot pass a cell wall, but a trap is carried out there. Consequently, only the purified exhaust gas is discharged from the downstream end face of the body of a filter. However, it is impossible to carry out the trap of the fine particulate completely only with a cell wall from the cell wall having the structure of passing exhaust gas. Here, the ceramic coat layer smaller than the average pore diameter of the body of a filter is prepared in the cell wall side which forms the through tube by which opening was carried out in the downstream end face of the body of a filter. Therefore, when exhaust gas passes a cell wall, even if the trap of the particulate is not carried out there, the trap of the particulate which passed through the cell wall is carried out in a ceramic coat layer. Therefore, it becomes possible to raise the particulate collection efficiency included in exhaust gas.
[0011] And at least one side is smaller than that of a cell wall among the average pore diameter of a ceramic coat layer, and average porosity. From this, it can be said that arrangement between the ceramic particles which constitute a ceramic coat layer is more precise than a cell wall. Therefore, a ceramic coat layer will bear the role which reinforces a cell wall, and it becomes possible to improve the mechanical strength of the body of a filter.
[0012] In invention according to claim 2, since the average thickness of a ceramic coat layer is thinner than that of a cell wall even if it makes a ceramic coat layer smaller than the average pore diameter of a cell wall, exhaust gas passes a ceramic coat layer smoothly. Therefore, the pressure loss of exhaust gas does not become so large that it is unusual.
[0013] According to invention according to claim 3 or 4, it becomes possible to make particulate collection efficiency the highest, without reducing most permeability of the exhaust gas to a cell wall.
[0014]
[Embodiment of the Invention] Hereafter, 1 operation gestalt which materialized the exhaust gas purification filter of this invention to the exhaust gas purge for diesel power plants is explained to a detail based on a drawing.
[0015] As shown in drawing 1 , this exhaust gas purge 11 is equipment for purifying the exhaust gas discharged from the diesel power plant 12 as an internal combustion engine. The diesel power plant 12 is equipped with two or more gas columns which are not illustrated. The tee 14 of an exhaust manifold 13 is connected with each gas column, respectively. Each tee 14 is connected to one manifold body 15, respectively. Therefore, the exhaust gas discharged from each gas column is concentrated on one place.
[0016] The 1st exhaust pipe 16 and the 2nd exhaust pipe 17 which consist of a metallic material are arranged in the downstream of an exhaust manifold 13. The upstream edge of the 1st exhaust pipe 16 is connected with the manifold body 15. The tubed casing 18 is arranged between the 1st exhaust pipe 16 and the 2nd exhaust pipe 17. The upstream edge of casing 18 is connected with the downstream edge of the 1st exhaust pipe 16, and the downstream edge of casing 18 is connected with the upstream edge of the 2nd exhaust pipe 17. It can also be grasped that casing 18 is arranged in the way of exhaust pipes 16 and 17. And as a result, the contrant region of the 1st exhaust pipe 16, casing 18, and the 2nd exhaust pipe 17 is mutually open for free passage, and exhaust gas flows the inside of it.
[0017] In casing 18, the cylinder-like body 19 of a filter is held. Since the body 19 of a filter is what removes a diesel particulate, generally it is called a diesel particulate filter (DPF). The heat insulator 20 is arranged between the peripheral face of the body 19 of a filter, and the inner skin of casing 18. A heat insulator 20 is the mat-like object formed including ceramic fiber.
[0018] The body 19 of a filter consisted of honeycomb members 21 of plurality (here 16 pieces), and they have pasted it up through the nature sealing layer 22 of a ceramic. Consequently, it is unified where each

honeycomb member 21 is bundled. If it is made such a configuration, with the stress resulting from the temperature gradient by heating, it can prevent that a crack occurs and will become strong also to a thermal shock about it. Therefore, enlargement of a filter can be attained comparatively easily.

[0019] The body 19 of a filter is a product made from a ceramic sintered compact (specifically porosity silicon carbide sintered compact). The body 19 of a filter is a product made from a porosity silicon carbide sintered compact which is a kind of a ceramic sintered compact. The reason for having adopted the silicon carbide sintered compact is that there is an advantage of especially excelling in reinforcement, thermal resistance, and thermal conductivity, as compared with other ceramics. As sintered compacts other than silicon carbide, sintered compacts, such as silicon nitride, an alumina, cordierite, and a mullite, can also be chosen.

[0020] Two or more through tubes 24 divided with the cell wall 23 are regularly formed in the body 19 of a filter along the direction of an axis. The thickness of a cell wall 23 is set up before and after 0.3mm. The array pitch of a through tube 24 is set up before and after 1.8mm.

[0021] As for the mean particle diameter of silicon carbide crystal grain child 23a of a cell wall 23, it is good that it is 5 micrometers - about 15 micrometers, and although particle size is 5 micrometers - 30 micrometers among said crystal grain child 23a, as for abundance, it is good that it is 30% or more.

[0022] As for the average pore diameter of a cell wall 23, it is desirable that they are 20 micrometers - 50 micrometers and 20 more micrometers - 30 micrometers. The blinding of the body 19 of a filter according that an average pore diameter is less than 20 micrometers to particulate deposition becomes remarkable. On the other hand, since it becomes impossible to carry out uptake of the fine particulate when an average pore diameter exceeds 50 micrometers, collection efficiency will fall.

[0023] As for the average porosity of a cell wall 23, it is desirable that they are 30% - 70% and 40 more% - 60%. There is a possibility of a cell wall 23 becoming it precise that average porosity is less than 30% too much, and becoming it being hard to circulate exhaust gas inside. On the other hand, if average porosity exceeds 70%, since an opening will increase too much in a cell wall 23, there is a possibility that may become weak in reinforcement and particulate collection efficiency may fall.

[0024] The closure of one of two openings formed in the both ends of each through tube 24 is carried out by turns with the sealing agent (here porosity silicon carbide sintered compact) 25. That is, in upstream end-face 19a, opening of the thing of an abbreviation moiety is carried out among the a large number through tubes 24, and opening of the remaining things is carried out in downstream end-face 19b. Therefore, as end-face 19a of the body 19 of a filter, and the whole 19b, it has become checker-like by existence of a sealing agent 25. The formation ingredient of a sealing agent 25 serves as the same product made from a porosity silicon carbide sintered compact as the body 19 of a filter.

[0025] Oxides, such as a cerium (Ce), are supported as a catalyst by the cell wall 23. Speaking concretely, using the cerium dioxide (CeO2) for the catalyst. And as for the amount with which the cerium dioxide is supported, it is desirable that it is within the limits of 0.10 - 5.0 g/l per unit volume of the body 19 of a filter, and if it is within the limits of 0.15 - 4.0 g/l, it can be said that it is the optimal.

[0026] It is also possible to use 3 cerium oxide (CeO3), or to use the mixture (Pt+CeO2) of a cerium dioxide and platinum etc. as a catalyst which the body 19 of a filter is made to support. Incidentally, the mixing ratio of a cerium dioxide and platinum serves as Pt:CeO 2= 1:1.

[0027] Moreover, an iron (Fe) oxide may be used as oxides other than a cerium. Speaking concretely, there being diacid-ized iron (FeO2) and three iron oxides (Fe 2O3). Furthermore, a copper (Cu) oxide may be used as oxides other than a cerium or iron. As mentioned above, the reason for having supported any one oxide among a cerium, iron, and copper on the body 19 of a filter is for lowering the temperature which can burn the diesel particulate by which uptake is carried out with the body 19 of a filter.

[0028] Next, the important section of this operation gestalt is explained. As shown in drawing 5 , coating of the ceramic coat layer 30 is carried out to the side face of the cell wall 23 which forms the through tube 24 by which opening was carried out in downstream end-face 19b of the body 19 of a filter. The formation ingredient of this ceramic coat layer 30 serves as the same product made from a porosity silicon carbide sintered compact as the body 19 of a filter.

[0029] The thickness of the ceramic coat layer 30 is set up more thinly than that of a cell wall 23. Speaking concretely, setting the average thickness of the ceramic coat layer 30 as 20 micrometers - 70 micrometers. It is hard coming to carry out uptake of the particulate which passed the cell wall 23 as the average thickness of the ceramic coat layer 30 is less than 20 micrometers. On the other hand, if average thickness exceeds 70 micrometers, it will be hard coming to pass exhaust gas.

[0030] As for the average pore diameter of the ceramic coat layer 30, it is desirable that they are 10

micrometers - 20 micrometers and 10 more micrometers - 15 micrometers. Although the thickness of the ceramic coat layer 30 is thin how much in an average pore diameter being less than 10 micrometers, the blinding of the ceramic coat layer 30 by particulate deposition becomes remarkable. On the other hand, if an average pore diameter exceeds 30 micrometers, since the average pore diameter of a cell wall 23 is resembled, uptake of the fine particulate which passed the cell wall 23 cannot be carried out, but collection efficiency will fall.

[0031] As for the average porosity of the ceramic coat layer 30, it is desirable that they are 10% - 30% and 10 more% - 20%. The ceramic coat layer 30 becomes it precise that average porosity is less than 10% too much, and there is a possibility that it may become impossible to circulate exhaust gas inside. On the other hand, if average porosity exceeds 30%, since the average porosity of a cell wall 23 is resembled, uptake of the particulate which passed the cell wall 23 cannot be carried out, but collection efficiency will fall.

[0032] As for the mean particle diameter of silicon carbide crystal grain child 30a which forms the ceramic coat layer 30, it is good that it is 2 micrometers - about 7 micrometers, and although mean particle diameter is 2 micrometers - 10 micrometers among crystal grain child 30a, as for abundance, it is good that it is 30% or more.

[0033] Next, the procedure of manufacturing the above-mentioned exhaust gas purification filter is explained. First, the paste for the closures used at the ceramic raw material slurry used at an extrusion-molding process and an end-face closure process is produced beforehand. What blended a binder and pure water the predetermined daily dose every, and kneaded them to the silicon carbide powder of a high grade (99.98%) as a ceramic raw material slurry is used. What blended and kneaded a binder, lubricant, the dispersant, and the diluent to the silicon carbide powder of a high grade (99.98%) as a paste for the closures is used.

[0034] Next, said ceramic raw material slurry is supplied to an extruding press machine, and it is continuously extruded through metal mold. Then, the honeycomb Plastic solid by which extrusion molding was carried out is cut to equal die length, and rectangle-like the piece of honeycomb member cutting is obtained. Furthermore, single-sided opening of each through tube 24 currently formed in the piece of honeycomb member cutting is filled up with the paste for the specified quantity [every] closures, and the both-ends side of each piece of cutting is closed.

[0035] Then, the desired honeycomb member 21 is completed by setting temperature, time amount, etc. as predetermined conditions, performing this baking, and sintering completely the piece of honeycomb member cutting, and a sealing agent 25. With this operation gestalt, burning temperature was set as 2100 degrees C - 2300 degrees C, and firing time is set up in 0.1 hours - 5 hours. Moreover, the furnace atmosphere at the time of baking is made into an inert atmosphere, and the pressure of the ambient atmosphere at that time is made into ordinary pressure. In addition, as for burning temperature, it is desirable to set it as said within the limits as much as possible at slight height.

[0036] Next, the inner skin of the specific cell wall 23 is coated with the ceramic coat layer 30. It is fundamentally [as a raw material slurry of the ceramic coat layer 30 / as the raw material slurry used for the sealing agent 25] the same. It is raising the concentration of lubricant or a diluent and reducing the viscosity of a raw material slurry as a different point.

[0037] And as shown in drawing 6 (a), the honeycomb member 21 is carried out longitudinally and the raw material slurry for forming the ceramic coat layer 30 is slushed into each through tube 24 currently formed in the honeycomb member 21. And with the side which slushes a raw material slurry, the raw material slurry slushed into the through tube 24 is attracted from the opposite side. As approaches other than this, as shown in drawing 6 (b), it is also possible to wash away a raw material slurry in a through tube 24 by pressures, such as air, from the side which slushes a raw material slurry. Or as shown in drawing 6 (c) and (d), it is also possible to vibrate the honeycomb member 21 and to slush a raw material slurry in a through tube 24 from one of the edges. Of course, although not illustrated, it is also possible to slush a raw material slurry from the both ends of the honeycomb member 21.

[0038] Drawing 6 (a) If a raw material slurry is passed by the approach explained by - (d), to the internal surface of a through tube 24, it can apply to a lower limit from the upper limit, and a raw material slurry can be spread equally. Especially the raw material slurry used for the ceramic coat layer 30 can form the thin ceramic coat layer 30, without being influenced of surface tension, since it is hypoviscosity.

[0039] After slushing a raw material slurry in a through tube 24, temperature, time amount, etc. are set as predetermined conditions, this baking is performed, and the ceramic coat layer 30 is completely sintered to the inside of a cell wall 23. And honeycomb member 21 comrades manufactured in this way are pasted up by the nature sealing layer 22 of a ceramic. Finally a diamond cutter cuts the pasted-up aggregate of the

honeycomb member 21 in the shape of a cylinder, and the cylindrical shape-like body 19 of a filter is acquired.

[0040] Using the exhaust gas purification filter which has the configuration mentioned above, exhaust gas is the following, and is made and purified. Exhaust gas is supplied to the body 19 of a filter held in casing 18 from the upstream end-face 19a side. The exhaust gas from a diesel power plant 12 flows in the through tube 24 which carries out opening in upstream end-face 19a of the body 19 of a filter. This exhaust gas passes a cell wall 23, and reaches the interior of the through tube 24 24 which adjoins it, i.e., the through tube which carries out opening in downstream end-face 19b of the body 19 of a filter. And exhaust gas flows out of downstream end-face 19b of the body 19 of a filter through downstream opening of this through tube 24.

[0041] However, the most will not be able to pass a cell wall 23, but the trap of the particulate contained in exhaust gas will be carried out there. However, the cell wall 23 is impossible for carrying out the trap of the fine particulate completely from having the structure of passing exhaust gas. Therefore, the trap of the particulate which passed through the cell wall 23 is carried out in the ceramic coat layer 30. That is, the trap of the fine particulate by which a trap was not carried out with the cell wall 23 with a large pore diameter is carried out in the ceramic coat layer 30 with a small pore diameter.

[0042] Consequently, the purified exhaust gas is discharged from downstream end-face 19b of the body 19 of a filter. After the purified exhaust gas passes the 2nd exhaust pipe 17 further, finally it is emitted to atmospheric air. In addition, with this operation gestalt, especially heating means for regeneration, such as a burner and a heater, are not formed in the upstream end-face 19a side of the body 19 of a filter. That is, this exhaust gas purge 11 has adopted the spontaneous ignition method. Therefore, the diesel particulate by which uptake was carried out only with the heat of exhaust gas burns.

[0043] Next, the effectiveness of this operation gestalt is explained.

(1) Coating of the ceramic coat layer 30 smaller than the average pore diameter of this cell wall 23 is carried out to the peripheral surface of the cell wall 23 with which the downstream end face of the body 19 of a filter forms the through tube 24 by which opening was carried out. Therefore, the trap of the fine particulate which passed through the cell wall 23 is certainly carried out in the ceramic coat layer 30. Therefore, the particulate collection efficiency included in exhaust gas can be raised.

[0044] (2) The average thickness of the ceramic coat layer 30 is set as 20-70 micrometers to the thickness of a cell wall 23 being 0.3mm. That is, the average thickness of the ceramic coat layer 30 is formed quite thinly compared with the thickness of a cell wall 23. Therefore, even if the average pore diameter or average porosity of the ceramic coat layer 30 is smaller than that of a cell wall 23, exhaust gas tends to pass the ceramic coat layer 30. Therefore, it can stop that the pressure loss of exhaust gas becomes large, and trouble is not caused to the fuel consumption engine performance of a diesel power plant 12.

[0045] (3) The average pore diameter of the ceramic coat layer 30 is set up within the limits of 10-20 micrometers. Moreover, the average porosity of a ceramic coat layer is set as 10 - 30% of within the limits. Therefore, particulate collection efficiency can be made the highest, without reducing most permeability of the exhaust gas to a cell wall 23. In short, setting up a numeric value within the limits of the above can carry out many uptake of the particulate contained in exhaust gas, without reducing the engine performance of a diesel power plant.

[0046] (4) Both the average pore diameters and average porosity of the ceramic coat layer 30 are smaller than that of a cell wall 23. It can be said that the ceramic coat layer 30 is more precise than a cell wall 23 as for this. Therefore, a cell wall 23 can be reinforced by existence of the ceramic coat layer 30, and the mechanical strength of the body 19 of a filter can be improved.

[0047] In addition, the operation gestalt of this invention may be changed as follows.

- With said operation gestalt, the average pore diameter and average porosity of the ceramic coat layer 30 were made smaller than that of a cell wall 23. In addition to this, one side may be made smaller than that of a cell wall 23 among the average pore diameter of the ceramic coat layer 30, and average porosity.

[0048] - With said operation gestalt, although one ceramic coat layer 30 was formed in the cell wall 23, the ceramic coat layer more than two-layer [from which average porosity and an average pore diameter differ] may be prepared. When the ceramic coat layer 30 is made two-layer, it is desirable to make smaller than that of the ceramic coat layer 30 which is outside the average pore diameter and average porosity of the ceramic coat layer 30 which are inside.

[0049] - The number of combination of the honeycomb member 21 may not be 16 pieces, and may be changed into the number of arbitration. In this case, of course, it is also possible to use it, combining suitably different honeycomb members 21, such as size and a configuration.

[0050] Next, the technical thought grasped according to the operation gestalt mentioned above is shown

below besides the technical thought indicated by the claim.
(1) It is the exhaust gas purification filter characterized by setting the average thickness of said ceramic coat layer as 5 - 25% to the thickness of a cell wall of within the limits in either of claims 1-4.
[0051] (2) It is the exhaust gas purification filter characterized by setting up the average pore diameter of said cell wall within the limits of 20-50 micrometers in either of claims 1-4.
[0052]
[Effect of the Invention] As explained in full detail above, according to this invention, the particulate collection efficiency included in exhaust gas can be raised.

[Translation done.]

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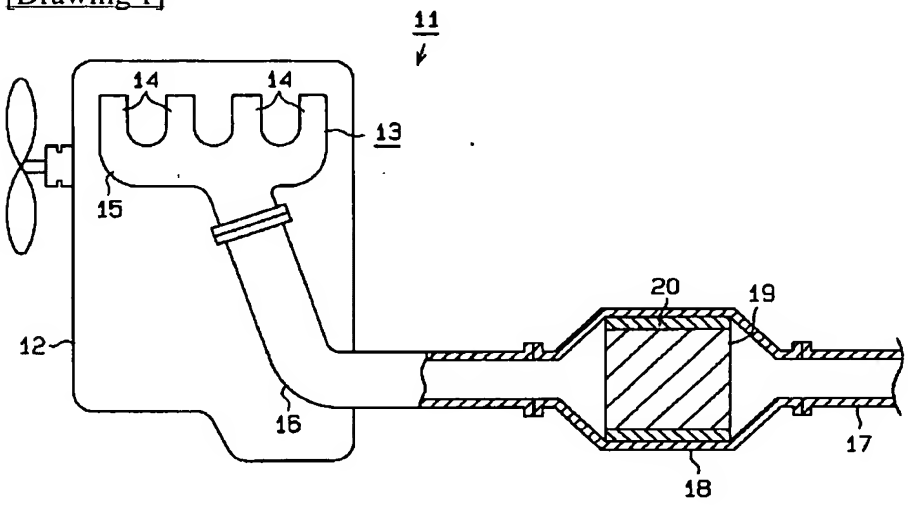
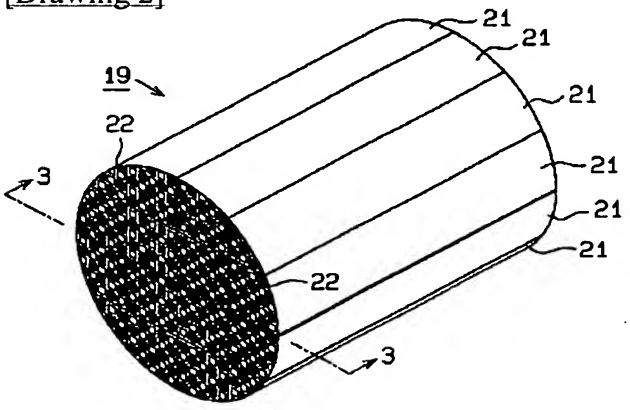
DRAWINGS

[Drawing 1]



[Drawing 2]



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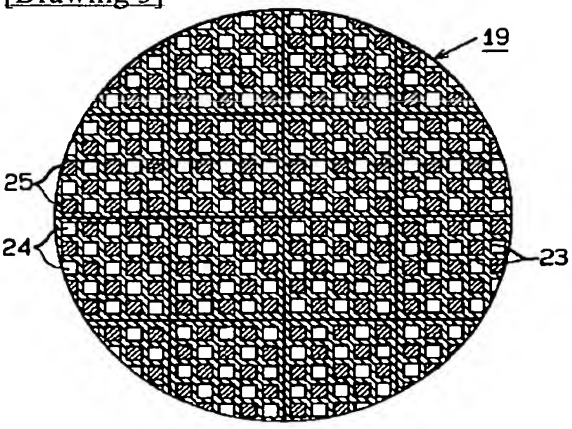

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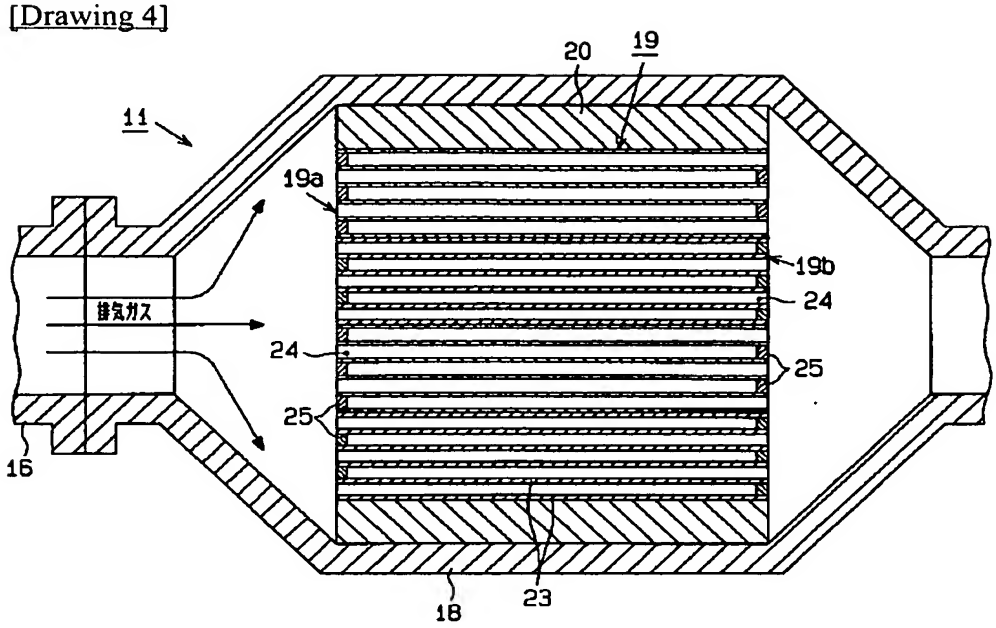

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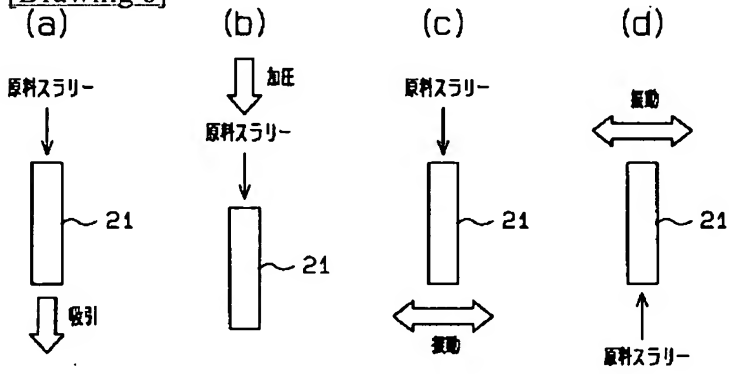
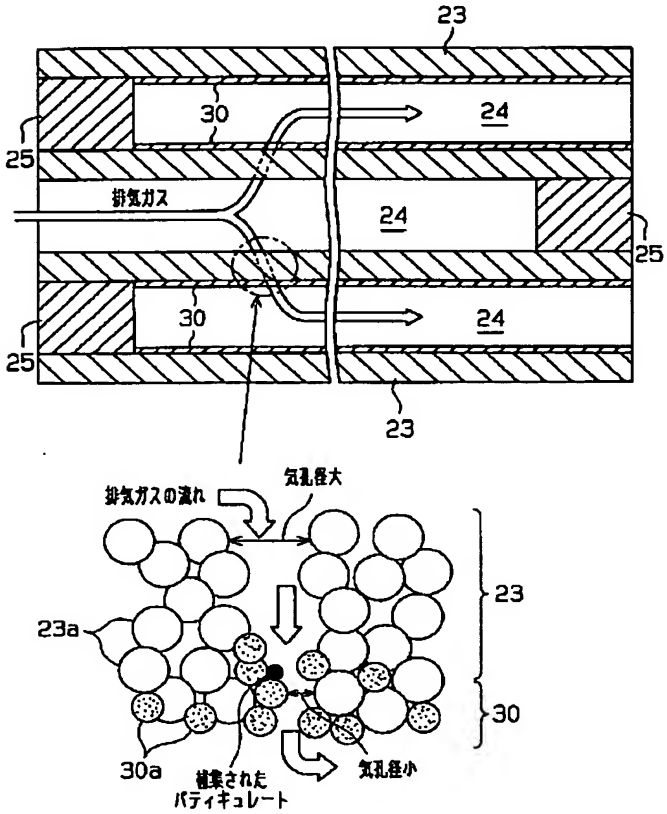


[Drawing 5]



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